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SUMMARY

Problem

Anecdotal reports suggested that tactical aviators experience levels of fatigue that could compromise their job performance.

Objective

The objective was to determine whether tactical aviators were experiencing fatigue that could affect job performance, and if so, to attempt to determine the source of their fatigue.

Approach

Surveys were distributed to a total of 78 combat aviators in two groups to determine sleeping habits and any problems with fatigue. All aircrews surveyed had completed a minimum of one fleet tour and included only Navy and Marine Corps aircrews in the F/A-18 and F-14 communities.

Results

The results of the surveys suggest that tactical aviators believe their job performance is compromised by fatigue. In the first survey, tactical aviators indicated that they believed fatigue affected their performance on a weekly basis. About one third of tactical aviators indicated that they had fallen asleep in the cockpit at least once, although it was unclear whether they were airborne during these episodes. Their fatigue does not appear to result from consistent sleep deprivation, although it may result from the cumulative effect of occasional missed sleep. Other

meet scheduling requirements.

Conclusions

Department of the Navy General Flight and Operating Instruction OPNAVINST 3710.7Q provides guidelines for the maximum recommended individual flight time according to the type of aircraft. It also provides guidance on the effect of circadian rhythms on performance and the importance of maintaining these rhythms for optimal functioning. However, our survey responses indicated that these guidelines are not always followed due to operational requirements. Increased awareness of established guidelines and compliance with these guidelines could enhance tactical aviators' levels of alertness and job performance. While there is an advantage to training that is realistic for combat situations, when fatigue must simply be endured, it is unclear that routine training should consistently disrupt circadian rhythms. Experienced naval tactical aviators believe that erratic scheduling leads to excessive levels of fatigue that compromise their performance. Given the cost of a mishap or accident, and the complaints of fatigue, serious consideration should be given to efforts to decrease the extent of tactical aviator fatigue.

Fatigue in Naval Tactical Aviators

There is a growing awareness of the problems produced by fatigue and the extent to which fatigue can compromise job performance. Several researchers have discussed the concept of sleep debt, which is the cumulative difference between the amount of sleep required per day and the amount obtained, and the effect of this sleep debt on job performance (Carskadon & Dement, 1982; Webb & Agnew, 1975). Sleep debt can produce a variety of deleterious effects on performance, including decreasing the speed of a response (Corsi-Cabrera, Arce, Ramos, Lorenzo, Guevara, 1996), as well as qualitative changes in performance. A sleepy person has a greater tendency to have periods of inattention, called lapses (Bills, 1931, 1958; Bjener, 1949; Patrick & Gilbert, 1896; Warren & Clarke, 1937; Williams, Lubin, & Goodnow, 1959). If critical information is presented during these lapses, the person will miss this information. Ultimately, the sleep-deprived person will fall asleep, possibly jeopardizing himself or herself and anyone in his or her charge. In the case of a tactical aviator, lapses of attention could be fatal, depending upon the timing and environment of the diminished alertness.

Sleep deprivation also affects combat aviator's resistance to the effects of motion sickness. When compared with inexperienced pilots, experienced pilots have a decreased vestibular sensitivity, that is shown in the intensity of nystagmus and the rate of recovery from nystagmus, which is induced by Coriolis acceleration (Dowd, 1973). Sleep deprivation of 24-30 hr interferes with vestibular habituation (Dowd, 1974; Dowd, Moore, & Cramer, 1975). The fatigue produced by sleep deprivation may make the experienced aviator more vulnerable to the effects of motion sickness.

Decreased alertness can result from sources other than sleep deprivation. Both time on task and circadian desynchronosis can produce fatigue. In a laboratory study of a data entry task, a 12-hr/4-day week was compared with an 8-hr/6-day week (Rosa, Wheeler, Warm, & Colligan, 1985). Participants who worked the longer day were more fatigued. This fatigue was manifested in increased errors and increased reaction times in tasks requiring more working memory, and in complaints of general fatigue and problems with concentration.

Things that have been done frequently become almost automatic and minimally involve working memory (Schneider & Shiffrin, 1977). However, during intellectually and physically demanding aerial combat maneuvers, during aircraft carrier operations, or when unexpected events occur, such as equipment failure, working memory is required for good performance. The fatigue produced by long workdays, such as a 12-hr workday, would likely reduce flying ability in demanding situations (Rosa et al., 1985).

Muscular weakness produced by long workdays could adversely affect aviator performance during high gravitational maneuvering. In another study of an extended workday, researchers found that after working a 10-hr/4-day week, grip strength was reduced when compared with a group who worked the standard 8-hr/5-day week (Volle, Brisson, Perusse, Tanaka, and Doyon, 1979). Flying a tactical aircraft during high gravitational maneuvers requires neck and upper back strength simply to maintain head position, and even more strength to move against the inertial forces. Additionally, the "anti-g" straining maneuver or "hook" maneuver (Whinnery & Murray, 1990), designed to preserve visual function and consciousness during these maneuvers, also requires good muscular strength and endurance.

Circadian desynchronosis (Reinberg et al., 1988) results from sleep/wake schedules that conflict with the body's circadian rhythms. This commonly occurs in rotating shift work schedules, and it can even occur in fixed work schedules in workers who are unable to adapt to the shift. Flying to a different time zone (jet lag) also produces circadian desynchronosis. A person who changes from working days to working nights and has to sleep during the day, or who travels to another time zone and has to sleep at a different time, will have a period where his or her body is adjusting to the new sleep regimen (Reite, Ruddy, & Nagel, 1997). Some individuals make this adjustment more successfully than others can (Quera-Salva, Defrance, Claustrat, De Lattre, & Guilleminault, 1996; Reinberg et al., 1980). However, if the new schedule is not stable, the circadian oscillators will perpetually adjust to the most recent schedule, which may produce nausea and fatigue. Acute circadian desynchronosis, such as that produced by jet lag in Olympic athletes, has resulted in decreased mood, anaerobic power and capacity, and dynamic strength (Hill, Hill, Field, & Smith, 1993). A person with circadian desynchronosis may have problems falling asleep during the available sleep time, and the quality of sleep may be decreased compared with his or her normal sleep quality (Reite et al., 1997).

Self-reported effects of fatigue on experienced tactical aviators were investigated using experienced tactical aviators. Due to anecdotal reports of tactical aviators experiencing excessive fatigue, we sought to determine whether tactical aviators perceived fatigue to be a problem that compromised their job performance, and to determine the source of any reported fatigue problems.

Method

Tactical aviators and naval flight officers (NFOs) who had deployed at least once were asked to complete a self-report questionnaire regarding sleep habits and possible fatigue problems. Everyone who was asked to participate volunteered. Their responses are considered representative of naval tactical aviators, which includes 499 F-14 Tomcat and 1,080 F/A-18 Hornet tactical aviators. To ensure that the information collected would be as accurate as possible, the surveys were anonymous. Participants were discouraged from including any remarks that might be used to identify them.

The survey was administered on two occasions to two different groups of aviators, with only slight modifications between the two surveys. The two versions of the survey, shown in Appendix A and Appendix B, were distributed to 46 and 32 participants, respectively.

Results

Both tactical aviators and NFOs completed the questionnaires. However, because only 10 NFOs completed the questionnaire, their data were not analyzed. One participant did not indicate his status, so his survey was not included. For both surveys combined, 67 tactical aviators completed surveys. Some questions were either not answered or misinterpreted, so the answer to the question could not be included. The mean and standard deviation for each question are shown in Table 1 and are broken down by survey. Only the responses to questions relevant to the research goals will be described.

The main purpose of this survey was to determine whether tactical aviators believed fatigue affected their performance, and if so, to determine the source(s) of this fatigue. Two survey questions directly addressed fatigue effects on performance. Tactical aviators were asked to rate the frequency of fatigue effects on their performance, and they were asked how many times they had fallen asleep in the cockpit.

In the first survey administration, tactical aviators were asked to indicate how often fatigue affected their performance on a weekly, monthly, or yearly basis. These ratings were annualized to make the estimates comparable. Of the 39 questionnaires in the first administration, 37 respondents (95%) answered this question. Of these respondents, 35 (95%) indicated that fatigue has affected their performance. Across all respondents, the average rating of the number of times per year that fatigue may have compromised performance was 51.7 times (SD = 49) per year, with a range of 2 to 182 times.

The tactical aviators were asked to indicate the number of times they had fallen asleep in the cockpit. The question was asked without clarification regarding whether the aviator was awaiting launch or in flight when he fell asleep. Twenty-five tactical aviators (38%) indicated that they had fallen asleep in the cockpit. They reported falling asleep from 1 to more than 10 times (which was coded as 10 times). On average, the tactical aviators who admitted having fallen asleep reported that this had happened 3.02 times (SD = 2.9) during their careers. However, it remains unclear whether tactical aviators were falling asleep during periods of minimal activity, such as awaiting launch, or whether they were falling asleep during flight.

The main goal of the research was to determine whether tactical aviators experience a problem with fatigue. The aviators' responses indicate that they are experiencing a problem with fatigue. The second goal of our research was to attempt to determine the source, or sources, of any fatigue tactical aviators experience. The three main sources of fatigue are sleep deprivation, time on task, and circadian desynchronosis.

To determine the adequacy of tactical aviator's sleep in preventing sleep deprivation and to determine the adequacy of the sleep timing to prevent circadian desynchronosis, the survey asked several questions about sleep habits. For the 64 aviators (96%) who answered the question about the time they go to bed when working days, the mean bedtime was 2251 (SD = .7 hr) and their mean waking time was 0600 (SD = .4 hr). For the 29 aviators in the first administration who answered the question about their bedtime and waking time when working nights, the average bedtime was 0031 (SD = 1.9 hr) and waking time was 0730 (SD = 1.9 hr). For the 64 aviators who answered the question about their bedtime and waking time on days off, the average bedtime was 2329 (SD = .9 hr) and waking time was 0739 (SD = 1.2 hr). These data are shown in Figure 1.

Sleep duration when working days was 7.15 hr (SD = .6 hr), and when working nights, it was 6.98 hr (SD = 1.0 hr). On days off it was 8.16 hr (SD = .9 hr). The 27 aviators in the second administration who answered the question about their sleep duration when they are very busy reported a sleep duration of 5.85 hr (SD = .6 hr).

The average number of minutes it took the aviators to fall asleep at night was 15.1 min (SD = 12 min). The number of awakenings during night sleep ranged from about zero to five times and averaged between one and two.

Aviators were asked whether they ever supplemented their nighttime sleep with naps during the daytime. The question was phrased so that it was only necessary to answer the question if the aviator napped. Of the 66 aviators who answered this question, 40 aviators (61%) said that they either did not nap or rarely napped. A few mentioned that time constraints prohibited napping. Twenty-six of the aviators (39%) indicated that they napped. Nap duration averaged 52 min (SD = 25 min), and the nap was taken in the midafternoon. They reported falling asleep for their nap in an average of 20 min (SD = 19 min).

In the second survey administration, 28 aviators answered the question regarding their number of awakenings during day sleep. Their range of awakenings was none to five. The average number of awakenings was between one and two.

The survey asked participants to rate their sleep, to rate factors that might interfere with sleep, and to rate fatigue problems when working at night. The quality of night sleep was rated by 67 aviators at 7.33 (SD = 1.2) on a 9-point scale, where 9 was labeled "Good" and 0 was labeled "Poor." For the 52 aviators who answered the question about the quality of sleep during the day, their average rating was 5.60 (SD = 2.4) on the same scale. The extent to which noise was problematic for sleep was rated 4.82 (SD = 2.8), where 0 was labeled as "A lot" and 9 was labeled as "A little." The extent to which light was problematic for sleep was rated 3.91 (SD = 2.8) on the same scale. Difficulty staying alert when working nights was rated 5.20 (SD = 2.1) where 0 was rated as "Hard" or "A lot" and 9 was rated as "Easy" or "A little" in the first and second survey administrations, respectively. These data are graphed in Figure 2. In the second survey administration, the extent of the increase in fatigue problems when deployed was rated 3.57 (SD = 2.6), where a 0 was rated as "A lot" and 9 was rated as "A little."

In addition to answering questions about their sleep habits, aviators were asked to select from a list, factors possibly responsible for any fatigue they experienced, which included work schedules, insufficient rest, night flying, jet lag, boredom, and other. The questionnaire provided space for them to describe their problems with work schedules and "other" fatigue factors. In the first survey administration, tactical aviators were asked to select from the same list, what factors contributed to their problem of falling asleep in the cockpit. Their responses to these two questions suggest that there may be multiple causes for their fatigue. Because of the importance of these questions, and because some putative fatigue resulted from multiple sources, the tactical aviators' responses to these questions will be described in detail.

When tactical aviators were asked to select factors responsible for their fatigue, the two most frequently identified problems were work schedules (80%), and insufficient rest (68%). Only 20% or fewer of the aviators identified the remaining categories of problems as contributors to their fatigue. Problems with boredom and "other" each were indicated by 20% of the aviators. The "other" factors that were mentioned were night airwing events, poor physical fitness, and poor sleep due to early awakening. Problems with night flying and jet lag were indicated by 18% and 12% of aviators, respectively.

The scheduling complaints were categorized according to general topic, although the topics overlapped. Because of the difficulty of categorizing data provided in a narrative format, the number of participants making a specific complaint can only be estimated. The majority of complaints fell into four categories: the crew day was too long, they were too busy, the scheduling was erratic, and there was insufficient time for crew rest. Some aviators identified more than one scheduling problem. These scheduling problems are related; the long crew day can lead to feeling too busy and can result in little flexibility in scheduling, so schedules may be erratic and may not provide adequate time for aviators to rest.

Of the aviators who identified scheduling as problematic, a majority of the specific complaints were that the crew day was too long. About 29 aviators reported this, which was half of the aviators who believed that work schedules caused their fatigue problems. Some specific comments were "12-15 hr days/6 days per week," "0600 -2130 daily," "schedule 12 hours and work 4 more," and "day always maxed (12 hrs not including debrief)."

The second most common complaint was that scheduling was erratic and impossible to predict in advance, which was indicated by about 11 tactical aviators (19%). Specific comments were "erratic flight schedules with A.M. work/meetings," "very early (pre-0700) briefs," "flying nights/switching to days, scheduled early one day, late the next," and "late airwing debrief, early brief."

The third most common category of complaint was that the workday was too busy, which was indicated by about 10 (17%) tactical aviators. Specific comments were "too hectic of a flow," "back-to-back brief and debrief," "overtasked, undermanned, continue to expand our charter," "we keep a hectic schedule," and "overtasking (4 ground jobs)."

Finally, about 5 tactical aviators (9%) reported that there was insufficient time for crew rest. Specific comments were "too much schedule conflicts with CR (crew rest)," "short crew rest," and "not enough time off from night landing until first brief the next day."

No survey questions specifically addressed either time on task or circadian desynchronosis. However, some information on these questions was provided by tactical aviators' responses to the questions about the sources of their fatigue. The majority of the aviators who indicated that scheduling was a problem and added a comment mentioned that the workday was too long or too busy. This is consistent with the length of the workday being contributory to fatigue.

Circadian desynchronosis can result from night work or changes in the duty hours. Some tactical aviators stated that their schedules shifted from day to day, and that a late-night mission followed by a debrief might be followed by an early morning briefing. These changes in scheduling would be expected to decrease circadian entrainment to the typical work shift and to produce some level of circadian desynchronosis, which would lead to fatigue.

Discussion

The results of these surveys provide evidence that the majority of tactical aviators surveyed have experienced problems with fatigue. In the first survey administration, aviators believed that fatigue deleteriously affected their performance on a weekly basis. More than one third of the aviators reported having fallen asleep in the cockpit an average of 3 times, although it is unclear whether the jet was actually airborne when these incidents occurred. This level of tactical aviator fatigue represents a potentially hazardous situation. Given that aviators reported fatigue, it is important to determine the source of that fatigue.

To determine whether sleep deprivation was causative in tactical aviator fatigue, we compared the aviators' sleep parameters with normative data. The average amount of sleep aviators obtained during the workweek was 7.15 hr. On days off, the average amount of sleep obtained was 8.16 hr. Most young adults reported sleeping 7.5 hr on weekday nights and sleeping 8.5 hr on weekend nights (Carskadon & Dement, 1994).

The sleep duration times are slightly less than some reported in population averages, but they are considered adequate in the opinion of some researchers (Harrison & Horne, 1995). Other researchers have suggested that obtaining 8.5 hr of sleep is better (Bonnet & Arand, 1995b). However, there is no consensus as to whether the extra sleep is required and performance enhancing. As indicated in these surveys, aviators reported getting almost as much sleep as young adults typically get, and obtaining this sleep during the normal time to sleep. If the sleep times the aviators provided represented realistic average times and not idealized "best case" times, then these aviators probably were getting enough sleep on a weekly basis.

Like most young adults, tactical aviators reported sleeping longer on the weekend. This suggests that they were not getting as much sleep as they needed during their working week (Carskadon & Dement, 1982; White & Mitler, 1997). Consequently, while they may not have developed a chronic sleep debt, they may have been mildly sleep-deprived during the workweek. Additionally, although the extra sleep obtained during the weekend helped to resolve their sleep debt, it may have shifted their circadian rhythms, which could have resulted in decreased performance at the beginning of the week.

In the second administration of the survey, tactical aviators were asked about the amount of sleep they typically got while deployed and during periods of high operational tempo. They reported sleeping 5.85 hr, which conflicts with the OPNAVINST 3710.7Q guidance that aviators should receive 8 hr of uninterrupted rest. Laboratory studies suggest that sleep lengths in this range will result in a significant sleep debt (Bonnet & Arand, 1995a; Rosenthal, Roehrs, Rosen, & Roth, 1993). This periodic sleep restriction would be expected to cause fatigue when deployed or when very busy. This interpretation is supported by their report of increased fatigue when deployed.

The amount of time it takes to fall asleep, known as the "sleep latency," decreases as sleepiness increases. Very short sleep latencies (less than 5 min) are generally thought to indicate pathological sleepiness from sleep deprivation or a sleep disorder like sleep apnea, rather than indicating an efficient sleeper (Carskadon & Dement, 1982). The 15-min sleep latency reported by aviators was somewhat less than the 24-min latency reported by another sample of young employed adults (Totterdell, Reynolds, Parkinson, & Briner, 1994), but it is well above the cutoff for pathological sleepiness. However, the fact that tactical aviators are essentially shift workers makes sleep latency data more difficult to interpret. About 25% of shift workers experience some aspect of shift-work sleep disorder (Gordon, Cleary, & Parker, 1986). One symptom of this disorder is difficulty initiating sleep. Thus, difficulty going to sleep due to shift-work sleep disorder might prolong sleep latency in some aviators, obscuring the effect of a sleep debt.

Tactical aviators only reported an average of 1 to 2 awakenings per night in both surveys, which is similar to the 1.8 average awakenings in a comparable sample (Totterdell et al., 1994). This suggests that their sleep was not fragmented, and it had long, continuous stretches. Obtaining continuous stretches of sleep is important because fragmented sleep may produce poorer performance despite an adequate number of hours of sleep (Roehrs, Merlotti, Petrucelli, Stepanski, & Roth, 1994).

Tactical aviators reported that the quality of their sleep was 7.33 on a scale of 0 "Poor" to 9 "Good". This compares favorably with a rating on a comparable sample, which would have been 6.26 on the same scale (Totterdell et al., 1994).

Of the tactical aviators who answered the question, 39% of aviators reported napping. Some aviators indicated that although napping was encouraged, there frequently was no opportunity to do so. This is unfortunate because a nap can produce a substantial increase in alertness. Naitoh (1992) found that a nap as short as 4 min and no longer than 20 min can prevent fatigue-induced deteriorations in cognitive performance. When working during hours normally reserved for sleep, performance can deteriorate up to 30%. However, if a person takes a nap, performance can be maintained at close to baseline levels (Bonnet, 1990).

Except when they are very busy, tactical aviators reported getting reasonable amounts of good quality sleep, at normal times, and with few awakenings. Their sleep latency appeared to be normal, but it is difficult to interpret given that aviators were sometimes required to do shift work. Additionally, some aviators supplemented their night sleep with daytime naps. From these data, it is unlikely that chronic sleep deprivation produced the fatigue that aviators experienced. However, it is possible that some of their reported fatigue was due to periodic sleep deprivation.

Time on task could be a major contributor to the fatigue experienced by tactical aviators (Krueger, 1989; Rosa, Colligan, & Lewis, 1989; Rosa et al., 1985; Volle et al., 1979). There were several comments to the effect that the duration of the crew day sometimes exceeded 12 hr for 5- to 6-day workweeks. As mentioned previously, a 12-hr/4-day week schedule resulted in fatigue, cognitive losses (Rosa et al., 1985) and a decrease in strength (Volle et al., 1979). Both mission planning and flying a jet are cognitively demanding and would be expected to be more tiring than data entry. It is difficult to determine from the information in this survey whether their long crewdays/workweeks are the cause. However, this possibility is consistent with their comments about the source of their fatigue.

Another source of the tactical aviator fatigue may be circadian desynchronosis due to scheduling that was insensitive to circadian rhythms and allowed the aviators little latitude in determining when they could sleep. The majority of aviators believed that scheduling problems contributed to their fatigue. Long, very busy, crew days, which are not scheduled in advance nor with the goal of maintaining circadian rhythms, or of allowing aviators to relax so that they can sleep at their normal time, could produce circadian desynchronosis.

In summary, there may be multiple sources for the fatigue that tactical aviators experience. Although there is little evidence for chronic sleep deprivation, some evidence suggests that during periods of high operational tempo, aviators were not getting enough sleep. Occasionally, scheduling problems may have prevented aviators from obtaining adequate sleep.

It is also possible that some of their fatigue resulted from circadian desynchronosis due to changing sleep periods. However, it is very likely that the major source of the fatigue that aviators have experienced resulted from the length of the crew day. This conclusion is supported by an analysis of naval aviation mishap data, which showed that pilot error was responsible for half of the losses of personnel and aircraft, and that these errors were statistically related to the hours worked in the previous 24 hr, but not to the other variables examined (Borowsky & Wall, 1983).

Tactical aviators are an elite group. Their job is both mentally and physically demanding. However, the problems aviators face may be comparable to problems faced by other individuals involved in vehicular transportation. About one third of tactical aviators reported falling asleep in the cockpit during their careers, which is arguably in the range of that reported in other vehicular transportation. In a survey of railroad engineers, 11% reported that they "dozed off" while driving the train for many or most night journeys, and 70% reported that they had "dozed off" while driving a train at least once during their careers (Åkerstedt, Torsvall, & Froberg, 1983). In another study, 36% of railroad engineers reported falling asleep. When the electroencephalograms (EEGs) of railroad engineers were recorded during driving, 18% of engineers failed to react to signals while their EEGs were showing a great deal of alpha activity and they were presumably drowsy (Torsvall & Åkerstedt, 1987).

Commercial pilots have also reported falling asleep in the cockpit. Seventy-one percent reported falling asleep in the cockpit at some point in their career (Rosekind, 1997). Given that tactical aviators are typically younger than train drivers and commercial pilots and have had fewer opportunities to fall asleep because of their shorter career spans, our findings may be comparable.

This survey was based on tactical aviators' ability to recall events and situations from memory. Further study would be useful in which information was gathered on a daily basis over a period of several days. For example, more accurate information would be obtained by asking aviators to provide their work schedules, their estimates of their job performance, feelings of fatigue, and their hours of sleep for each day at a specific time each day. Requesting this information for a single day would allow more accurate estimations of each answer than would asking questions retrospectively. Gathering information in this way would allow determination of the adequacy of their sleep duration, and determination of any relationship among feelings of fatigue, actual sleep duration (in contrast with average sleep duration), and estimated work performance. To determine possible circadian desynchronosis, each aviator's body temperature could be monitored. Of the biological rhythms, body temperature is the most closely associated with the circadian rhythm of sleepiness (Roth, Roehrs, Carskadon, & Dement, 1994). This method of data collection would provide data that are less affected by memory problems and more reflective of the aviator's actual situation.

The results of the survey suggest that fatigue is problematic for Navy tactical aviators. Tactical aviators reported that excessively long crew days, erratic scheduling, and insufficient sleep have produced fatigue problems that degraded their performance. OPNAVINST 3710.7Q provides maximum recommended individual flight time according to the type of aircraft. It also provides guidance on the effect of circadian rhythms on performance and the importance of maintaining these rhythms for optimal functioning. While there is an advantage to training that is realistic for combat situations when fatigue must simply be endured, it is unclear that routine training should consistently disrupt circadian rhythms. Experienced naval tactical aviators believe that erratic scheduling has lead to excessive levels of fatigue that has jeopardized mission performance. Tactical aviator pilot errors may cause an aircraft mishap, which could result in injury, death, loss of a multimillion dollar aircraft, and damage to property on the ground. Apart from the emotional consequences of any loss of life, death of an aviator means that millions of dollars invested in training the tactical aviator has also been lost. Given the emotional and financial cost of an accident and the problems with fatigue, serious consideration should be given to efforts to decrease tactical aviator fatigue. Their difficulties emphasize the ubiquitous nature of fatigue and that it cannot be overcome simply by force of will or typical tactical aviator "can do" attitude.

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Appendix A

1. Are you a (circle one) pilot or an NFO?

2. Estimate your usual bedtime_______and wake time______ when you are working days.
3. Estimate your usual bedtime_______and wake time______ when you are working nights.
4. Estimate your usual bedtime_______and wake time______ on days off.

5. How long does it usually take you to fall asleep at night? ________min. During the day?________min

6. How many times do you usually awaken during a typical night sleep (circle)? 0-1 2-3 4-5 6 or more
   Or during a typical day sleep? 0-1 2-3 4-5 6 or more

5. If you sometimes nap to supplement your main sleep period, please indicate timing and length.
   ____

6. Estimate your usual number of caffeinated drinks per day (coffee, soft drinks, tea).________

7. If your caffeine consumption differs between day work and night work, describe.__________________

8. Estimate you daily consumption of nicotine (# cigarettes, amount of chewing tobacco, etc.).____________

9. Rate your usual sleep when you sleep at night. Poor 0 1 2 3 4 5 6 7 8 9 Good

10. Rate your usual sleep when you sleep during the day. Poor 0 1 2 3 4 5 6 7 8 9 Good

11. When you sleep in a noisy area, how much does it bother your sleep?
    A lot 0 1 2 3 4 5 6 7 8 9 A little

12. When you sleep in a lighted environment, how much does it bother your sleep?
    A lot 0 1 2 3 4 5 6 7 8 9 A little

13. How hard is it to remain alert when working nights? Hard 0 1 2 3 4 5 6 7 8 9 Easy

14. How frequently do you feel that fatigue may possibly affect your ability to do your job?
    _______times per (circle one) week month year

15. What factors do you think contribute to this? Check all that are applicable.
    Work schedules_______(Describe)____
    Insufficient rest______ Night flying______
    Jet lag_______ Boredom______
    Other (describe)____

16. How many times have you fallen asleep in the cockpit?_______

17. What factors do you think contribute to this? Check all that are applicable.
    Work schedules_______(Describe)____
    Insufficient rest______ Night flying______
    Jet lag_______ Boredom______
    Other (describe)____

18. Please describe on the back of the questionnaire examples of fatigue or sleep occurring in the cockpit. Do not state dates or locations, but time of day, flight duration, recent sleep history, and type of aircraft would be very helpful.

Appendix B

1. Circle one: Pilot, NFO.

2. Estimate your usual workday bedtime_______and wake time______ .
3. Estimate your usual day off bedtime_______and wake time______ .
4. During deployed periods of high operational tempo, how much sleep do you typically get in a day?

5. How long does it usually take you to fall asleep at night? ________ during the day?________

6. How many times do you usually awaken during a typical night sleep (circle)? 0-1 2-3 4-5 6 or more
   Or during a typical day sleep? 0-1 2-3 4-5 6 or more

7. If you nap to supplement your main sleep period, indicate typical length and time of day.
   ____

8. Estimate your usual number of caffeinated drinks per day (coffee, sodas, etc.).________

9. Estimate your usual number of caffeinated drinks during periods of high operational tempo.__________________

10. Estimate your daily use of nicotine (# cigarettes, amount of chewing tobacco).____________

11. Rate your usual sleep when you sleep at night. Poor 0 1 2 3 4 5 6 7 8 9 Good

12. Rate your usual sleep when you sleep during the day. Poor 0 1 2 3 4 5 6 7 8 9 Good

13. When you sleep in a noisy area, how much does it bother your sleep?
    A lot 0 1 2 3 4 5 6 7 8 9 A little

14. When you sleep in a lighted environment, how much does it bother your sleep?
    A lot 0 1 2 3 4 5 6 7 8 9 A little

15. How hard is it to remain alert when working nights? A lot 0 1 2 3 4 5 6 7 8 9 A little

16. When on deployed status how much greater a factor does fatigue become for you?
    A lot 0 1 2 3 4 5 6 7 8 9 A little

17. What factors most contribute to fatigue? (Circle all applicable)
    Scheduling (describe)__________________________________
    Insufficient rest
    Jet lag
    Night missions
    Boredom
    Other (describe)____

18. How many times have you fallen asleep in the cockpit?_______

19. Please describe on the back of the questionnaire examples of excessive fatigue that have compromised cockpit performance or sleep in the cockpit. DO NOT PROVIDE IDENTIFYING INFORMATION. Names, dates, or locations are not important, but time of day, flight duration, type mission, recent sleep history, and type aircraft would be very helpful.

Table 1

Mean Item Values for Survey Responses

Question	Survey Results		
	Survey One mean (SD) n	Survey Two mean (SD) n	Average mean (SD) N
Bedtime when working days	2247 (.8 hr) 37	2257 (.5 hr) 27	2251 (.7 hr) 64
Waking time when working days	0554 (.4 hr) 37	0609 (.4 hr) 27	0600 (.4 hr) 64
Sleep duration when working days	7.11 hr (.7) 37	7.20 (.5 hr) 27	7.15 hr (.6 hr) 64
Bedtime when working nights	0031 (1.9 hr) 29	na	0031 (1.9 hr) 29
Waking time when working nights	0730 (1.9 hr) 29	na	0730 (1.9 hr) 29
Sleep duration when working nights	7.0 hr (1.0 hr) 29	na	6.98 hr (1.0 hr) 29
Bedtime on days off	2333 (1.0 hr) 37	2323 (.7 hr) 27	2329 (.9 hr) 64
Wake time on days off	0738 (1.2 hr) 37	0740 (1.0 hr) 27	0739 (1.2 hr) 64
Sleep duration on days off	8.40 (.9 hr) 37	8.28 hr (.9 hr) 27	8.16 hr (.9 hr) 64
Sleep duration when busy	na	5.85 hr (.6) 27	5.85 hr (.6) 27
Time to fall asleep at night	15.0 min (11) 38	15.3 min (14) 28	15.1 min (12) 66
Number of awakenings during night sleep	1-2 39	1-2 28	1-2 67
Percentage of aviators who napped	42% 38	25% 28	39% 66

Table 1. (continued)

Question	Survey Results		
	Survey One mean (SD) n	Survey Two mean (SD) n	Average mean (SD) N
Time to fall asleep during the day	23 min (23) 29	16 min (10) 17	20 min (19) 46
Nap duration	49 min (24) 16	57 min (27) 10	52 min (25) 26
Nap timing	midafternoon 4	midafternoon 7	midafternoon 11
Number of awakenings during day sleep	na	1-2 28	1-2 28
Percentage of caffeine users	95%	93%	94%
Caffeinated beverages per day	3.35 (2.2) 39	2.48 (1.6) 28	2.66 (2.2) 67
Caffeinated beverages per day when busy	na	3.61 (2.1) 28	3.61 (2.1) 28
Percentage of nicotine users	11%	4%	8%
Nicotine use among users (cigarettes or pinches)	4.0 (1) 4	5.0 (0) 1	4.2 (1) 5
Night sleep quality	7.56 (.9) [a] 39	7.18 (1.4) [a] 28	7.33 (1.2) [a] 67
Day sleep quality	5.55 (2.4) [a] 33	5.74 (2.4) [a] 19	5.60 (2.4) [a] 52
Noise effect on sleep	5.08 (2.6) [b] 38	4.46 (3.2) [b] 28	4.82 (2.8) [b] 66
Light effect on sleep	4.45 (2.89) [b] 38	3.32 (2.6) [b] 28	3.91 (2.8) [b] 66
Problems staying alert	5.29 (2.3) [c] 35	5.04 (1.9) [b] 28	5.20 (2.1) [b, c] 64

Table 1. (continued)

Question	Survey Results		
	Survey One mean (SD) n	Survey Two mean (SD) n	Average mean (SD) N
Fatigue problems during deployment	na	3.57 (2.6) [b] 28	3.57 (2.6) [b] 28
Annualized frequency of fatigue problems	51.7 (49) 37	na	51.7 (49) 37
Factors responsible for fatigue			
work schedules	74% 38	82% 28	80% 66
insufficient rest	61% 38	79% 28	68% 66
night flying	16% 38	29% 28	18% 66
jet lag	8% 38	18% 28	12% 66
boredom	18% 38	25% 28	20% 66
other	8% 38	39% 28	20% 66
Percentage of aviators who have fallen asleep in the cockpit	39% 38	36% 28	38% 66
Times fallen asleep in cockpit	3.60 (3.5) 15	2.15 (1.5) 10	3.02 (2.9) 25
Factors responsible for falling asleep			
work schedules	80% 15	na	80% 15
insufficient rest	93% 15	na	93% 15
night flying	40% 15	na	40% 15

Table 1. (continued)

Question	Survey Results		
	Survey One mean (SD) n	Survey Two mean (SD) n	Average mean (SD) N
jet lag	0% 15	na	0% 15
boredom	47% 15	na	47% 15
other	7% 15	na	7% 15

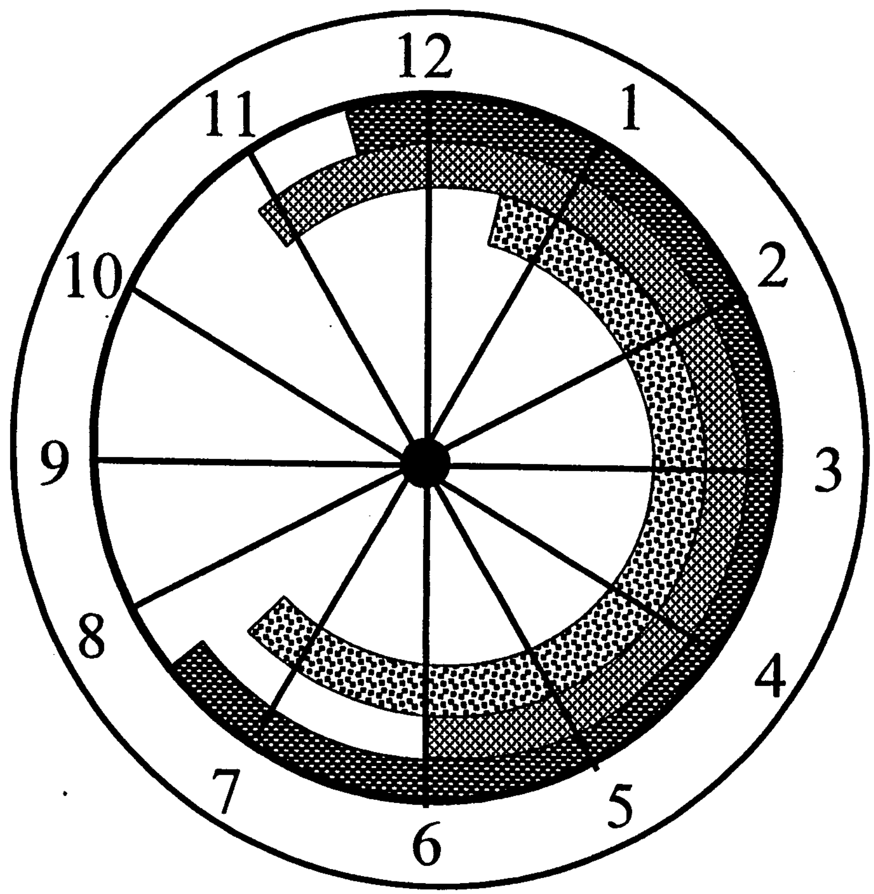
Note. SD = standard deviation. na = not asked.
[a] This rating was on a scale where 0 was labeled as "Poor" and 9 as "Good." [b] This rating was on a scale where 0 was labeled "A lot" and 9 was labeled "A little." [c] This rating was on a scale where 0 was labeled "Hard" and 9 was labeled "Easy."

Figure Captions

Figure 1. Time spent sleeping as a function of work situation.

Figure 2. Rating of the quality of day and night sleep, and the disturbing effects of noise and light.

Hours of Sleep

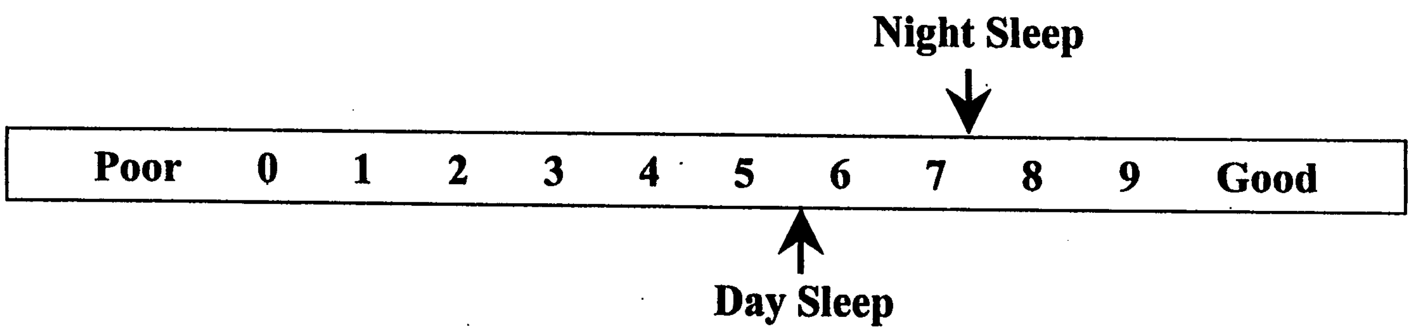


Days Off: 11:29pm - 7:39am (8.16hrs)

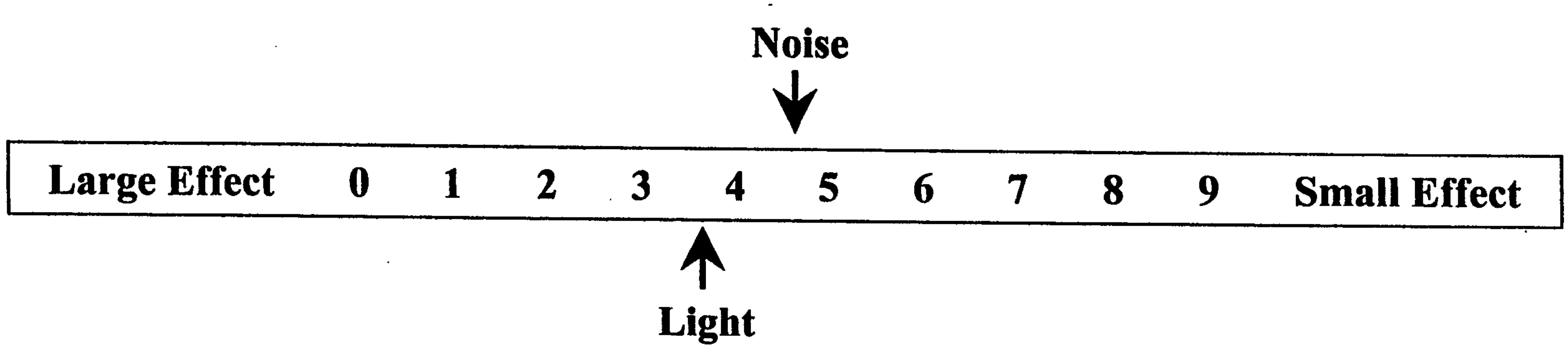
Working Days: 10:51pm - 6:00am (7.15hrs)

Working Evenings: 12:31pm - 7:30am (6.89hrs)

Rating of Sleep Quality



Rating of Sleep Disturbances



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14. ABSTRACT (maximum 200 words)

Surveys were distributed to 78 tactical aviators in two groups to determine their sleeping habits and any problems with fatigue. All aircrews surveyed had completed a minimum of one fleet tour and included only Naval and Marine Corps aircrews in the F/A-18 and the F-14 communities. The results of the survey suggest that tactical aviators believe their job performance is compromised by fatigue. Tactical aviators in the first group indicated that they believed that fatigue affected their performance on a weekly basis. About one third of tactical aviators indicated that they had fallen asleep in the cockpit at least once, with an average of three times in their careers. Their fatigue does not appear to result from sleep deprivation. It may result from working long days and having to shift their sleep cycle to meet scheduling requirements. Given the cost of a mishap or accident, and the complaints of fatigue, serious consideration should be given to efforts to decrease the extent of tactical aviator fatigue.

15. SUBJECT TERMS
Fatigue, circadian rhythms, sleep deprivation, circadian desynchronosis

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